**0/20** Questions Answered

# Mid-Semester Exam (COMP1130)

STUDENT NAME

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## **Q1** Acknowledgment

0 Points

COMP1130 Mid-Semester Exam, Semester 1 2021

You must acknowledge the following **integrity pledge** before proceeding. Please read carefully and check all the boxes.

□ I am committed to being a person of integrity.

□ I pledge, as a member of the ANU community, to abide by and uphold the standards of academic integrity outlined in the ANU statement on honesty and plagiarism, I am aware of the relevant legislation, and understand the consequences of breaching those rules.

□ I will not communicate in any way with anyone else during this exam. This includes asking questions in any online forum.

□ I acknowledge that this exam is protected by copyright and that copying or sharing any of its content will violate that copyright.

Read and check off the following instructions:

1. This examination is timed.

□ Note the remaining time at the top right of this screen. Set an alarm for yourself if you need one.

2. Permitted materials. This is an open book exam. You might in particular find the course Website, the Prelude documentation, and the Data.List documentation useful.

□ You may use any documentation you wish but **all work must be your own**.

Save Answer

## **Q2** Types

2.5 Points

Consider the following Haskell function signature:

```
foo :: String -> Int -> String
```

Select which of the following is false:

○ `foo "a" 1` can be given a type.

○ `foo "a"` can be given a type.

○ `foo "a" 1 "a"` can be given a type.

○ `foo ['a','b']` has type `Int -> String`.

○ `foo "abc" 2` has type `String`.

Save Answer

## Q3 Haskell Functions

2.5 Points

Consider the following Haskell type signature:

```haskell
myFun :: Bool -> Bool -> Bool
```

Four of the following implementations of this function behave the same.

A.

```haskell
myFun a b = case (a,b) of
  (True, True)   -> True
  (True, False)  -> False
  (False, True)  -> False
  (False, False) -> True
```

B.

```haskell
myFun a b = a == b
```

C.

```haskell
myFun a b
  | a == True && b == True = True
  | otherwise = False
```

D.

```
myFun a b = (a && b) || not (a || b)
```

E.

```
myFun False False = True
myFun a b = a && b
```

Select which one behaves *differently* than the others?

○ A

○ B

○ C

○ D

○ E

Save Answer

## **Q4** Type Signatures

2.5 Points

Consider the following Haskell function definition:

```
bar a b = abs a + a / b
```

Which of the following is a valid Haskell type signature for this function?

○ `bar :: Integer -> Integer -> Double`

○ `bar :: Int -> Double -> Double`

○ `bar :: Int -> Int -> Int`

○ `bar :: Int -> Int -> Double`

○ `bar :: Double -> Double -> Double`

Save Answer

## **Q5** Lists

2.5 Points

Which of the following statements is *false* in Haskell:

○ A list of functions can be defined.

○ `[[], [], [[]], [1]]` is a valid list.

○ Lists can be used in recursive functions.

○ Infinite lists can be constructed.

○ An empty list is often used as a base case in recursion.

Save Answer

## **Q6** Sets and Functions

5 Points

Select which of the following are True or False:

### **Q6.1** Sets

1 Point

$(\text{False}, 1)$ is an element of the set $\mathbb{B} + \mathbb{Z}$.

○ True

○ False

Save Answer

### Q6.2

1 Point

Given $f :: A \to (B \to C)$, $a$ an element of $A$, and $b$ an element of $B$, then $(f(a))(b)$ is an element of $C$.

○ True

○ False

Save Answer

### **Q6.3** Functions

1 Point

Mathematical functions are pure.

○ True

○ False

Save Answer

### **Q6.4** Sets and Functions

1 Point

Given sets $A$ and $B$, then $A \to B$ represents the set of all possible functions from $A$ to $B$.

○ True

○ False

Save Answer

### **Q6.5** Sets

1 Point

The set $\mathbb{B} \times \mathbb{B}$ has 8 elements.

○ True

○ False

Save Answer

## Q7 Haskell

2 Points

Select which of the following are True or False:

### Q7.1 Type Safety

1 Point

Haskell is dynamically typed.

○ True

○ False

Save Answer

### Q7.2 Lists

1 Point

A list in Haskell can only have elements of the same type.

○ True

○ False

Save Answer

## Q8 Lists and Strings

3 Points

Consider the following Haskell function definition:

```
tail' xs = case xs of
  [] -> []
  _:ys -> ys
```

Select which of the following are True or False:

### **Q8.1** Strings

1 Point

A valid type signature for the expression `tail' "comp1100"` is `[Char]`.

○ True

○ False

Save Answer

### **Q8.2** Lists

1 Point

`tail' []` gives the same result as `tail' [[]]`.

○ True

○ False

Save Answer

### **Q8.3** Lists

1 Point

`tail' [True, False]` returns `False`.

○ True

○ False

Save Answer

## **Q9** Lambda Expressions

2.5 Points

Consider the following lambda term:

$$(\lambda x.\,(x\;x)\;\lambda y.\,y)\;(x\;\lambda y.\,z)$$

Select which of the following terms has the same meaning, after removing as many brackets as possible:

○ $\lambda x.\, x\, x\, \lambda y.\, y\, (x\, \lambda y.\, z)$

○ $\lambda x.\, (x\, x)\, \lambda y.\, y\, x\, \lambda y.\, z$

○ $\lambda x.\, (x\, x)\, \lambda y.\, y\, (x\, \lambda y.\, z)$

○ $(\lambda x.\, x\, x\, \lambda y.\, y)\, (x\, \lambda y.\, z)$

○ $(\lambda x.\, (x\, x)\, \lambda y.\, y)\, x\, \lambda y.\, z$

Save Answer

## **Q10** Beta Reduction

2.5 Points

Consider the following lambda term:

$$(\lambda w.\, \lambda x.\, w\, x\, \lambda y.\, w\, y)(\lambda z.\, x\, y)$$

Select which of the following is (alpha-equivalent to) the result of applying one step of beta-reduction to that term:

○ $\lambda t.\, (\lambda z.\, t\, u)\, t\, \lambda u.\, (\lambda z.\, t\, u)\, u$

○ $\lambda t.\, (\lambda z.\, x\, y)\, t\, \lambda u.\, (\lambda z.\, x\, y)\, u$

○ $(\lambda w.\, w\, (\lambda u.\, u\, y))(\lambda z.\, x\, y)$

○ $(\lambda x.\, (\lambda u.\, u\, y)\, x)(\lambda z.\, x\, y)$

○ $\lambda x.\, (\lambda z.\, t\, u)\, x\, \lambda y.\, (\lambda z.\, t\, u)\, y$

Save Answer

## **Q11** Beta Reduction

2.5 Points

Consider the following lambda term:

$$(\lambda u.\, (\lambda v.\, v\, u)(u\, w))((\lambda x.\, x\, y)\, z)$$

Select which of the following is the result of reducing that term as far as possible,
using non-deterministic beta-reduction:

○ $y\,z\,(u\,w)$

○ $y\,z\,w\,(y\,z)$

○ $y\,z\,(y\,z\,w)$

○ $z\,y\,(u\,w)$

○ $z\,y\,w\,(z\,y)$

○ $z\,y\,(z\,y\,w)$

Save Answer

## **Q12** Lambda Encodings

2.5 Points

Select which of the following is a correct term for a function that doubles a natural number?

(You may assume that all the combinators used in the definitions below are already defined. Provided the encodings are correct, it should not matter which encoding is used.)

○ $\lambda x.\ \mathsf{if}\ \mathsf{iszero}\ x\ \mathsf{then}\ x\ \mathsf{else}\ \mathsf{succ}\ \mathsf{succ}\ \mathsf{Y}\ \lambda f.\ \mathsf{pred}\ x$

○ $\lambda x.\ \mathsf{if}\ \mathsf{iszero}\ x\ \mathsf{then}\ x\ \mathsf{else}\ \mathsf{succ}\ (\mathsf{succ}\ (\mathsf{Y}\ \lambda f.\ \mathsf{pred}\ x))$

○ $\lambda x.\ \mathsf{Y}\ \lambda f.\ \mathsf{if}\ \mathsf{iszero}\ x\ \mathsf{then}\ x\ \mathsf{else}\ \mathsf{succ}\ \mathsf{succ}\ f\ \mathsf{pred}\ x$

○ $\lambda x.\ \mathsf{Y}\ \lambda f.\ \mathsf{if}\ \mathsf{iszero}\ x\ \mathsf{then}\ x\ \mathsf{else}\ \mathsf{succ}\ (\mathsf{succ}\ (f\ (\mathsf{pred}\ x)))$

○ $\mathsf{Y}\ \lambda f.\ \lambda x.\ \mathsf{if}\ \mathsf{iszero}\ x\ \mathsf{then}\ x\ \mathsf{else}\ \mathsf{succ}\ \mathsf{succ}\ f\ \mathsf{pred}\ x$

○ $\mathsf{Y}\ \lambda f.\ \lambda x.\ \mathsf{if}\ \mathsf{iszero}\ x\ \mathsf{then}\ x\ \mathsf{else}\ \mathsf{succ}\ (\mathsf{succ}\ (f\ (\mathsf{pred}\ x)))$

Save Answer

## **Q13** Programming Questions

30 Points

The programming questions are distributed to you via gitlab.

- You can find the exam gitlab repository at https://exam-gitlab.cecs.anu.edu.au.
- Do not change the name of this repository, or we will not be able to mark your exam.

- You should clone **your** repository to your local machine to do your work.
- During the exam, tutors will be available on Piazza and Teams so that students can get help in case of technical problems.
- Once you have cloned the exam you should answer the programming questions in the given Haskell files.
- After you complete each question you should **commit and push** your work to gitlab. We recommend that you check if your push was successful at your repository on gitlab.

Save Answer

Save All Answers

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